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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

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YAWED-LANDING INVESTIGATION OF A MODEL OF THE CONVAIR Y2-2 AIRPLANE

TED NO. NACA DE 363

By Edward L. Hoffman and Lloyd J. Fisher

Langley Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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SUMMARY

A model of the Convair Y2-2 airplane was tested in Langley tank no. 2 to determine whether satisfactory stability in yawed landings was possible with a certain ventral fin. Free-body landings were made in smooth and rough water at two speeds and two rates of descent with the model yawed 15°. The behavior of the model was determined by visual observations and from motion-picture records.

It was concluded that satisfactory stability was possible with the ventral fin as tested but that the characteristics of the model shock absorbers and the settings of the elevon control surfaces had an appreciable influence on behavior.

INTRODUCTION

The Convair Y2-2 airplane is a 16,500-pound, jet-propelled, delta-wing configuration incorporating a hydro-ski landing gear. Preliminary investigations by Convair indicated that a ventral fin was necessary in order to insure satisfactory directional stability during yawed landings on the water (reference 1). The present investigation was made at the request of the Bureau of Aeronautics, Department of the Navy, to determine whether another ventral fin proposed by Convair, smaller than that reported in reference 1 and more suitable structurally for installation on the airplane, would provide satisfactory stability.

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In the course of the investigation it was found that the characteristics of the model shock absorbers and the settings of the elevon control surfaces had an appreciable influence on behavior. Consequently, the investigation was extended to include tests of the effect of these parameters on the directional stability.

DESCRIPTION OF MODEL

A $\frac{1}{10}$-scale dynamic model of the Y2-2 airplane, supplied by Convair, was used in the investigation. The model was built of balsa wood with hardwood inserts at points of concentrated load. Photographs of the model, designated Langley tank model 286, are shown in figure 1 and basic dimensions of the model and full-scale airplane are given in table I and figure 2. It was necessary, in order to balance the model about the desired center of gravity, that the tests be made at a weight about 5 percent higher than that listed in table I.

Pneumatic shock absorbers were installed on the model employing the original check-valve system shown in figure 3. The air pressure in the system was about 45 pounds per square inch gage (model scale) for most of the tests. The area of each shock-absorber piston was about 0.2 square inch and the full stroke was about 3 inches (model scale). The check-valve arrangement was changed during the investigation and instead of the single original valve, two valves were installed, one on each strut as shown in figure 3. The compression rates of the shock absorbers under constant loads of 1 g and 2g were about 2 feet per second and 4 feet per second, respectively, and the extension rate under no load was about 3 feet per second (full scale).

The model was equipped with elevons which could be deflected from 15° to -30° and a rudder which could be deflected from 20° to -20°. The control surfaces were adjustable to fixed positions on the model as received from Convair. During the investigation, however, the elevon installation was altered so that, on contact with the water, the elevons would return to a zero setting.

APPARATUS AND PROCEDURE

All landings were made with the model initially yawed 15°. Landings were made at two speeds and two rates of descent corresponding approximately to the full-scale values given in table II. The landings were made in calm water and perpendicular to oncoming waves 5 feet high and

250 feet long (full scale). The calm-water tests were made at the Langley tank no. 2 monorail and the rough-water tests were made with the tank no. 2 towing carriage.

The model was landed by catapulting or releasing it into the air to permit a free glide onto the water. The model left the launching gear laterally level, at scale speed and at the desired landing attitude and angle of yaw. The control surfaces were set so that the roll, attitude, and yaw did not change appreciably in flight. The behavior of the model was determined by visual observations and from motion-picture records obtained with two cameras - one mounted overhead and one mounted at the side of the tank.

RESULTS AND DISCUSSION

The landings made in calm water with the model as received from Convair were usually good. Occasionally, however, the model was directionally unstable and ran in a curved path in a direction opposite to that in which it was yawed at landing. Generally, on these runs, when the model crossed over to an opposite tack it rolled over abruptly. This motion was called a waterloop in reference 1.

The rough-water landings made with the original model configuration resulted in numerous waterloops. In both calm- and rough-water landings, when one hydro-ski became more heavily loaded than the other, its shock absorber tended to collapse and the other shock absorber to extend fully. Also, when the elevons entered the water an unbalance in hydrodynamic forces was apparently caused by the differential elevon settings that were necessary for aerodynamic trim. Both these conditions, which promoted a sharp turn usually followed by a waterloop, were apparently idiosyncrasies peculiar to the model and not inherent in the airplane.

The two-valve shock-absorber system (one valve for each strut) was adopted to prevent interaction of one strut with the other. Landings in both calm and rough water with this system showed a marked improvement in stability. The shock absorbers as tested were not scale models of those to be used on the airplane, since the actual design information was not available.

A system for returning the elevons to zero at water contact was devised to prevent the unbalance in hydrodynamic forces observed with differential elevon settings. This modification also improved the stability of the model. When the shock-absorber and control-surface modifications were used in combination, excellent directional stability was obtained in both calm and rough water.

In calm water at the higher-attitude landings the model usually made a gradual turn in a direction opposite to the initial yaw. At the lower attitudes the model had more tendency to follow a straight path while remaining in a somewhat yawed condition. In the rough-water tests skipping was the characteristic behavior during the landings. The model tended to correct the initial yaw at first contact with the water or while in the air before the second contact. The lower attitude landings, with the proportionately higher speeds, resulted in the most skipping. High angles of trim, roll, and yaw were sometimes assumed in these skips, but the model always recovered. The rates of descent of the model had little or no noticeable effect on the behavior.

The size of the ventral fin as tested (see table I and figs. 1 and 2) apparently was quite adequate. A larger ventral fin would not be expected to improve the rough-water stability as obtained with the original shock absorber and elevon settings because the model was thrown clear of the water. A larger ventral fin might have improved the behavior in calm water but was unnecessary for adequate stability in the final model configuration.

CONCLUSIONS

The following conclusions are based on yawed landing investigations of a model of the Convair Y2-2 airplane:

1. Satisfactory stability in yawed landings was obtained with the ventral fin as tested.

2. The characteristics of the model shock absorbers and the settings of the elevon control surfaces had an appreciable influence on behavior.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va.

Edward L. Hoffman

Edward L. Hoffman
Aeronautical Research Scientist

Lloyd J. Fisher

Lloyd J. Fisher
Aeronautical Research Scientist

Approved: John B. Parkinson
John B. Parkinson
Chief of Hydrodynamics Division

JLC

REFERENCE

1. Caldwell, Robert W., Jr.: Interim Progress Report on Y2-2 Hydrodynamic Development. Rep. No. ZH-2-003, Consolidated Vultee Aircraft Corp., Oct. 1950.

TABLE I

GENERAL DIMENSIONS OF CONVAIR Y2-2 AIRPLANE

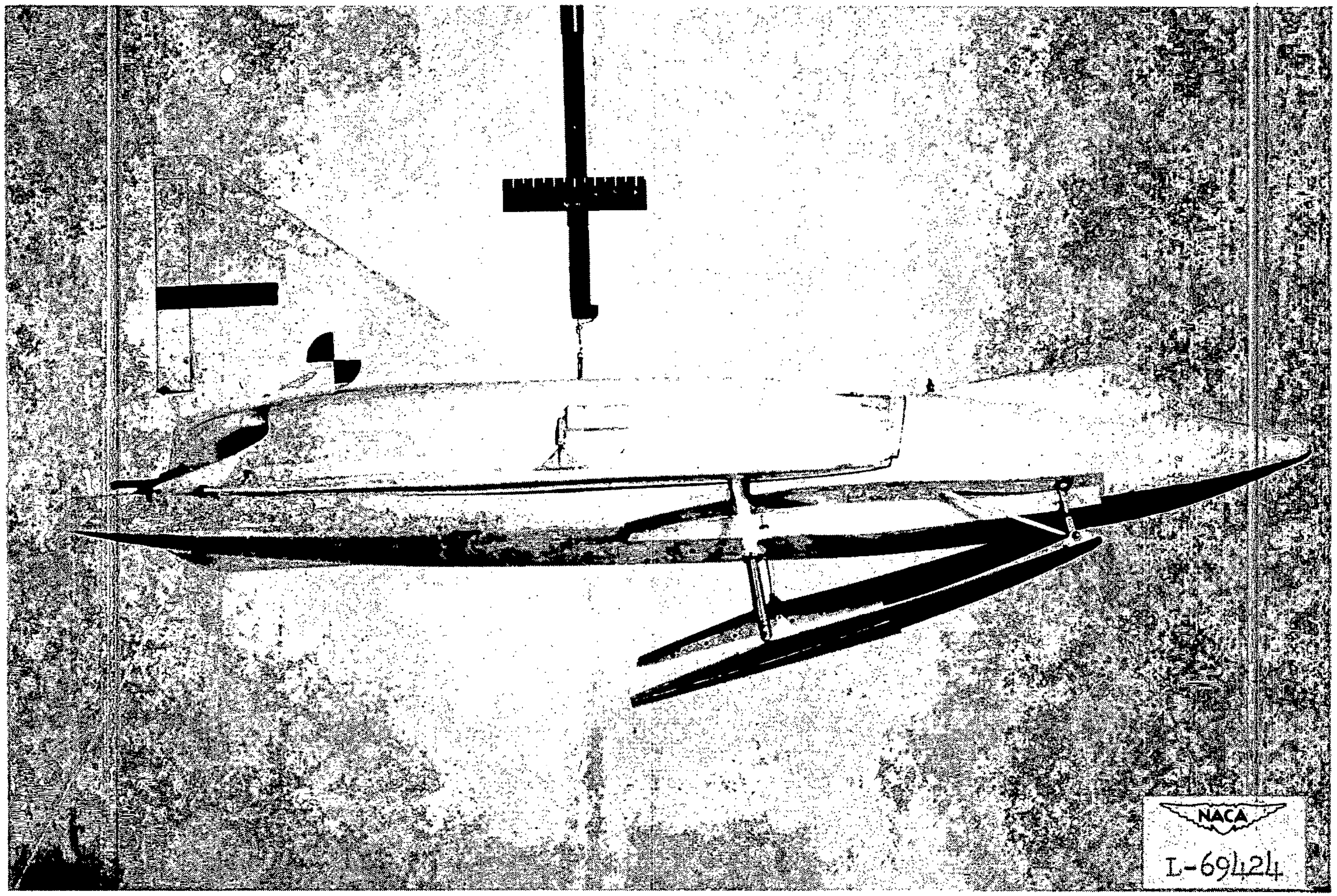
AND LANGLEY TANK MODEL 286

	Full scale	Model
Gross weight, lb	16,500	16.5
Wing:		
Area, sq ft	550	5.5
Span, in.	406	40.6
Sweepback (leading edge), deg	60	60
Dihedral, deg	1.5	1.5
Root chord, in.	370	37
Mean aerodynamic chord, in.	246.9	24.69
Center-of-gravity location, percent M.A.C.	30	30
Hull:		
Length, in.	627	7
Elevons:		
Area, sq ft	49	0.49
Vertical tail:		
Area, sq ft	70	0.70
Ventral fin:		
Area, sq ft	2.7	0.027

TABLE II

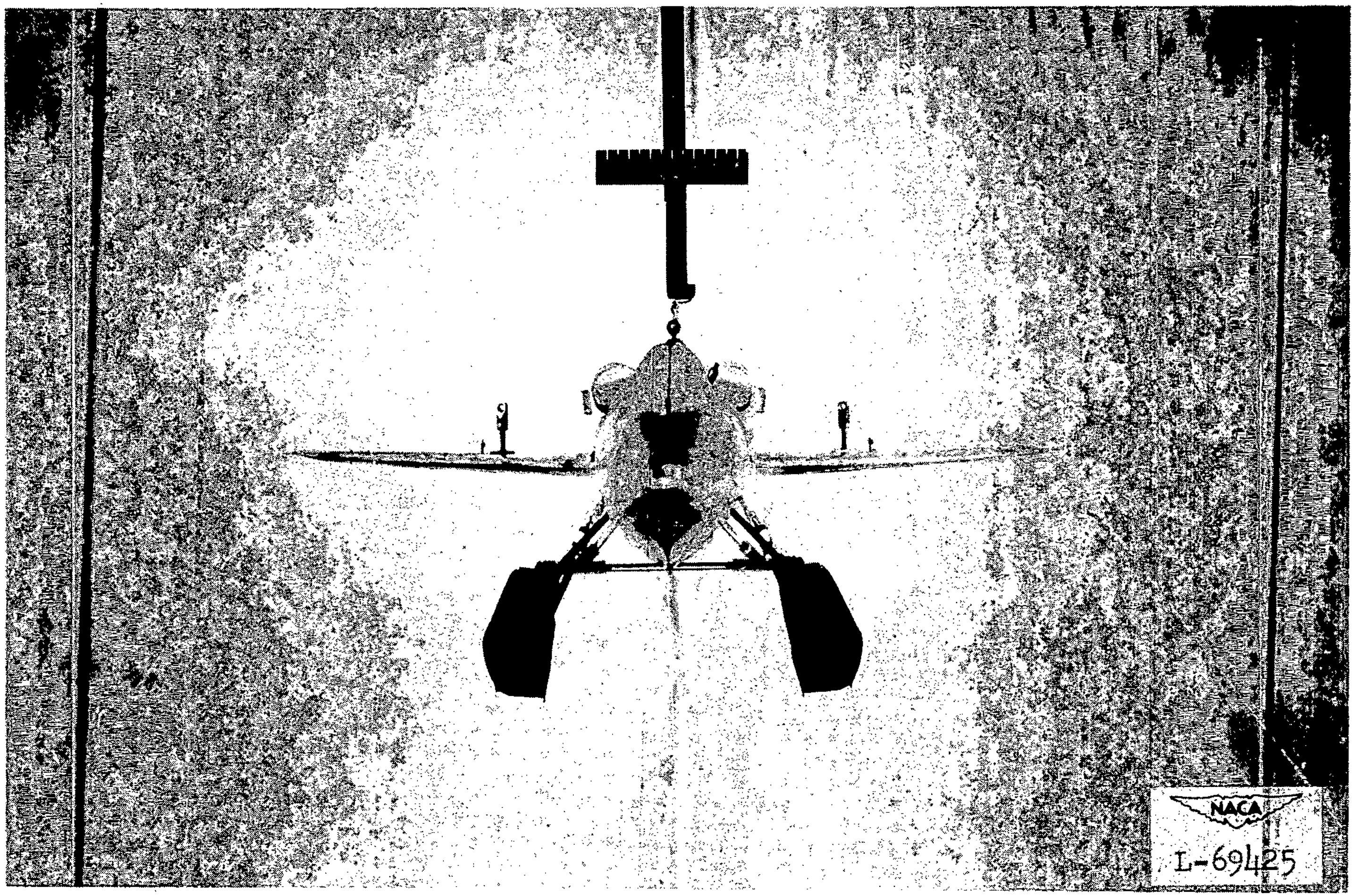
LANDING SPEEDS AND ATTITUDES FOR THE CONVAIR Y2-2 AIRPLANE

Horizontal speed (knots)	Vertical speed (fps)	Flight-path angle (deg)	Attitude with flight path (deg)	Attitude with water surface (deg)
96	8	3	20	17
96	17	6	20	14
109	8	$2\frac{1}{2}$	$13\frac{1}{2}$	11
109	17	5	$13\frac{1}{2}$	$8\frac{1}{2}$



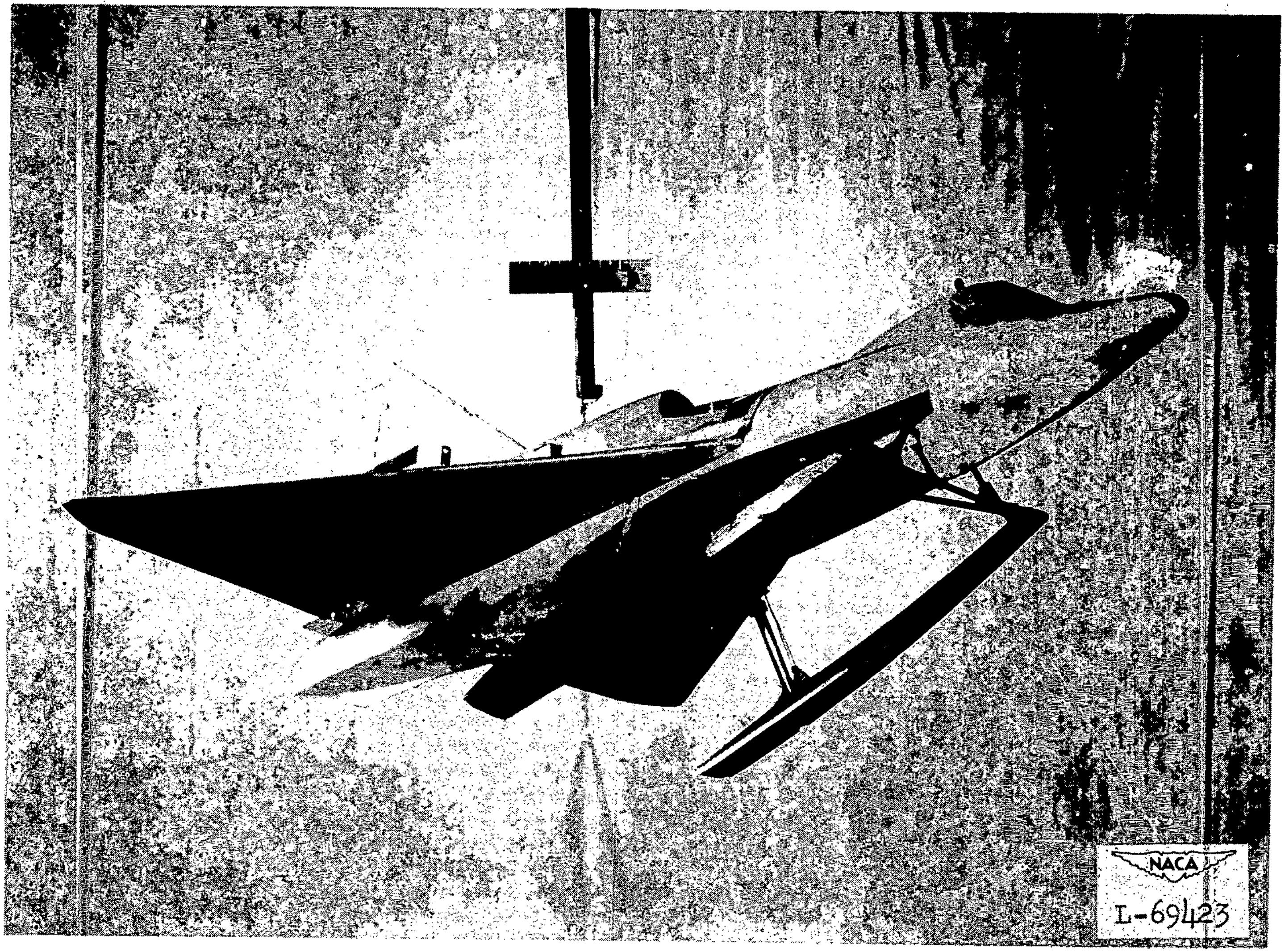
(a) Side view.

Figure 1.- Langley tank model 286.



(b) Front view.

Figure 1.- Continued.



(c) Three-quarter view.

Figure 1.- Concluded.

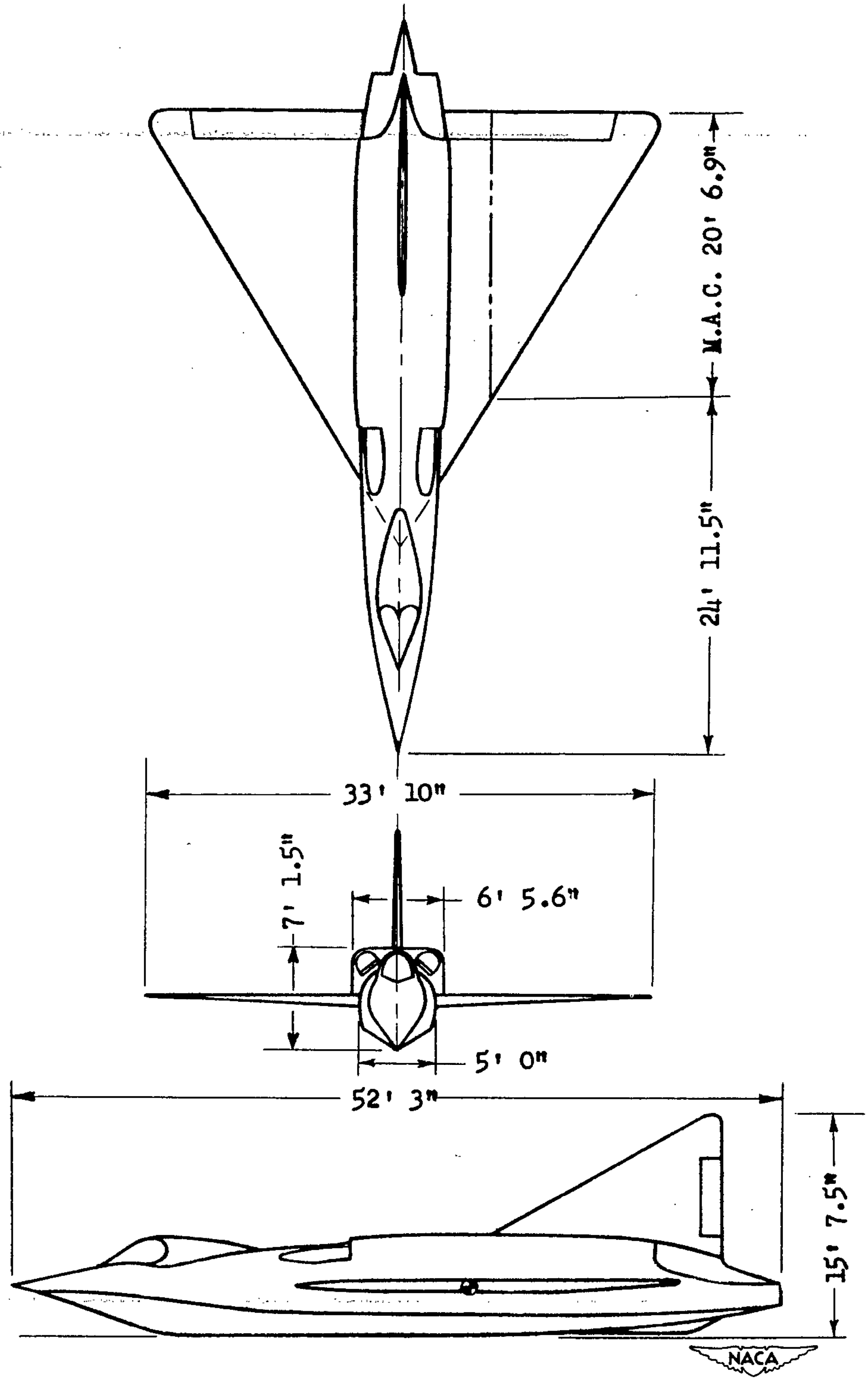


Figure 2.- Three-view drawing of the Y2-2 airplane. Dimensions are full scale.

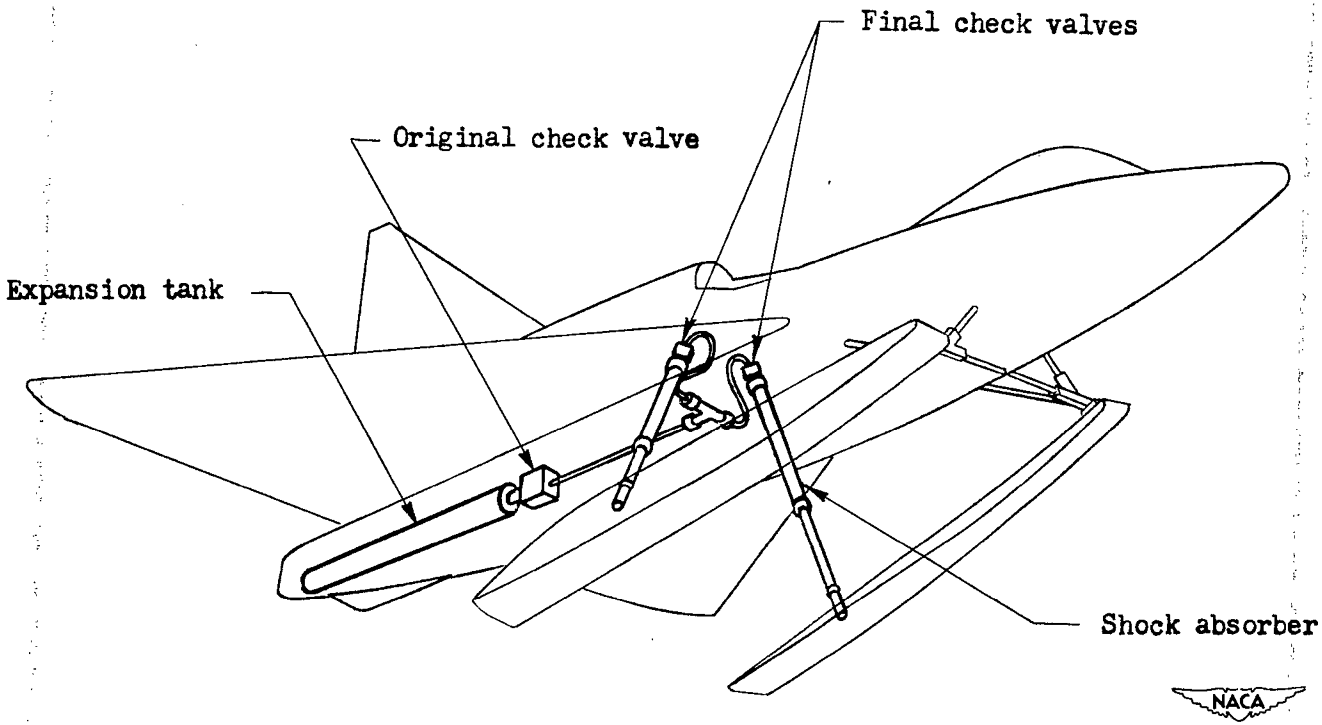


Figure 3.- Model shock-absorber system.

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